

# HBD report

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# “Hybrid” subtraction

Mixed event + Rel. acc. corrected correlated yield

- Subtract combinatoriale + rel. acc. corrected correlated yield
  - Normalization for mixed event background: Zero yield at minimum:  $N_{zyam}$
  - Combinatoriale is estimated from unlike sign mixed event :  $N_{zyam} \times BG12$
  - Correlated yield is estimated from acc. corrected like sign correlated yield:  
 $\alpha((FG11 + FG22) - N_{zyam} \times (BG11 + BG22))$
  - Signal:  $S12 = FG12 - \{N_{zyam} \times BG12\} - \alpha \times \{(FG11 + FG22) - N_{zyam} \times (BG11 + BG22)\}$

Relative acceptance correction

- Usually Rel. acc. is simply :  $\alpha_{COMBI} = BG11/(BG11 + BG22)$
- It's not guaranteed that  $\alpha_{COMBI} = \alpha_{CORR}$
- Test using pythia simulations

Zero yield at min assumption error

Let's say  $N_T = N_{zyam} + \delta N$

$$\begin{aligned} S12_{zyam} &= FG12 - \{(N_T - \delta N) \times BG12\} - \alpha_{CORR} \times ((FG11 + FG22) - (N_T - \delta N) \times (BG11 + BG22)) \\ &= S12_T + \delta N(BG12 - \alpha_{CORR} \times (BG11 + BG22)) \end{aligned}$$

# Notes on “hybrid” subtraction

## A little subtlety with $\alpha$

- If the following three conditions are true:
  - $\alpha$  and all  $FG$  and  $BG$  histograms are of identical binning
  - $\alpha$  is calculated from the ratio  $BG12/(BG11 + BG22)$
  - $\alpha$  correction is done bin by bin

then term 2 and 3 in the subtraction equation cancel, ie.

$$N_{zyam} \times BG12 = \alpha \times N_{zyam} \times (BG11 + BG22)$$

- This implies that the “hybrid” method is mathematically identical to the “acceptance corrected like sign” method
- The only use of hybrid method is therefore if
  - $\alpha$  is calculated by some other method than from mixed event background
  - $\alpha$  is rebinned to absorb some of the statistical fluctuation at high  $m_T$

# Normalization region in $m$ vs. $p_T$

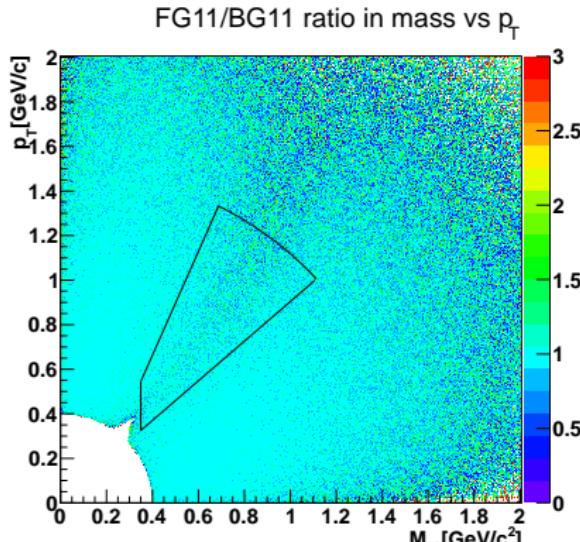
- Integrate FG11 and BG11 in the region:

$$\Omega \in (m > 0.35) \text{ and } (p_T < (-0.27 - 2.33m)) \text{ and } (p_T > 0.01 + .9m) \text{ and } (m_T < 1.5^2)$$

$$I(FGXX) = \int_{\Omega} dm dp_T \frac{dFGXX(m, p_T)}{dm dp_T}$$

$$I(BGXX) = \int_{\Omega} dm dp_T \frac{dBGXX(m, p_T)}{dm dp_T}$$

- Normalization factor for BG:  $N = \sqrt{\frac{I(FG11) \times I(FG22)}{I(BG11) \times I(BG22)}}$



# Eid, event cuts and CabanaBoy settings

## Singles cuts

- $0.2\text{GeV} < p_T < 20 \text{ GeV}$ ,  $e/\text{core} > 0.15 \text{ GeV}$ ,  $e/p > 0.6$ ,  $n_0 \geq 3$ ,  $\text{disp} < 5.5 \text{ cm}$ ,  $\chi^2/npe0 < 20.0$ ,  $\text{qual} = 31||51||63$
- Emcal matching cut  
( $\text{fabs(emcdz} + 1.0) < 10.0 \&\& \text{fabs(emcdphi} + 0.005) < 0.03$ )
- PHENIX central arm +- acceptance (Butsyk cut)
- Hbd strut conversion cut: if  $\phi > 0.75 \&\& \phi < 2.4$  then  $e/p < 0.9$

## Event cuts and Ghost rejection

- $z_{\text{vtx}} < 20.0 \text{ cm}$
- Many ghost rejection strategies tested (details later)

## HBD cuts

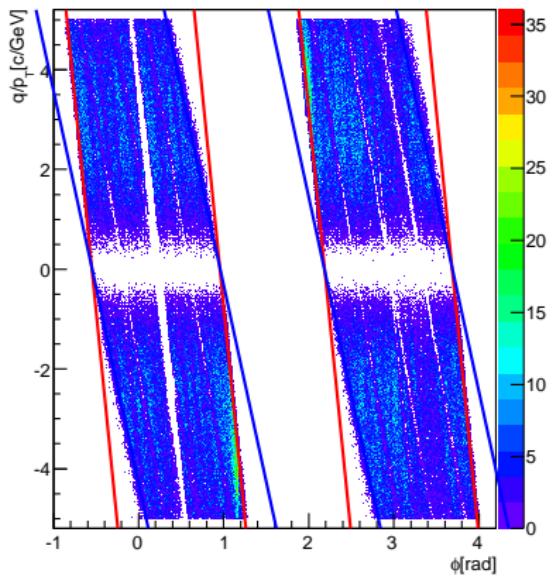
- Backplane rejection  $q_{HBD,1cm} > 10 \text{ pe}$
- Double rejection  $q_{HBD,2cm} < 30 \text{ pe}$
- These cuts are applied after normalization

# Acceptance cut

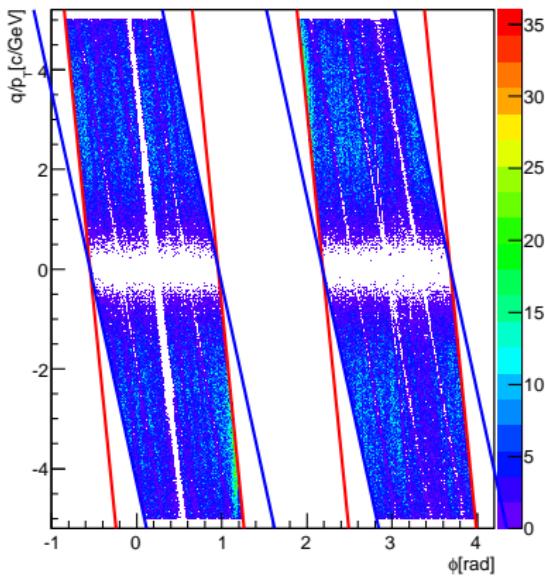
New "into PHENIX" acceptance for +- field

- Determined from +- RD by cutting slightly narrower than actual acceptance.
- Acceptance for -+ is the same but the charge is inverted

Real data  $q/p_T$  vs.  $\phi$



Real data  $q/p_T$  vs.  $\phi$



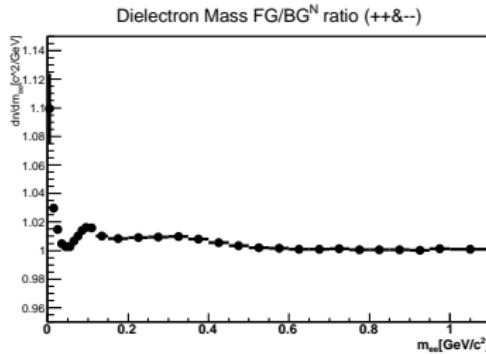
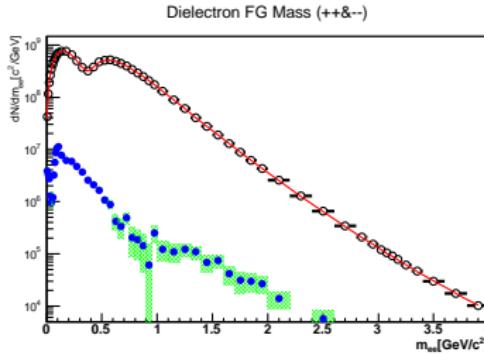
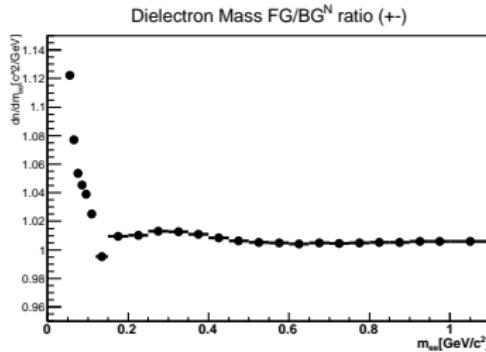
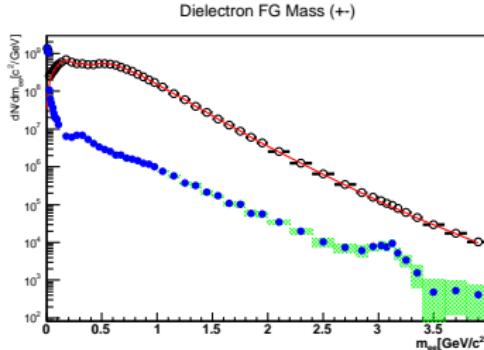
# Step 1: $FG - N_{zyam} \times BG$

## Combinatorial subtraction

- The first step is to subtract the normalized mixed event background  $N_{zyam} \times BG$  from the foreground  $FG$ .
- This is done both for both the like and unlike sign, in  $m$  vs.  $p_T$  plane, in each event mixing pool in centrality and zvertex
- The subtracted signal contains correlated background in both like and unlike, as well as signal in the unlike sign.
- The like sign combinatorial subtracted foreground is later corrected in  $m$  vs.  $p_T$  plane by the relative acceptance correction  $\alpha$  within each pool, projected on the mass axis and subtracted from its like sign counterpart to get the final answer.
- As stated before, the normalization is calculated before any HBD cut is applied
- The  $FG - N_{zyam} \times BG$  plots shown below have been summed over the z vertex pools for sake of shortening the presentation.

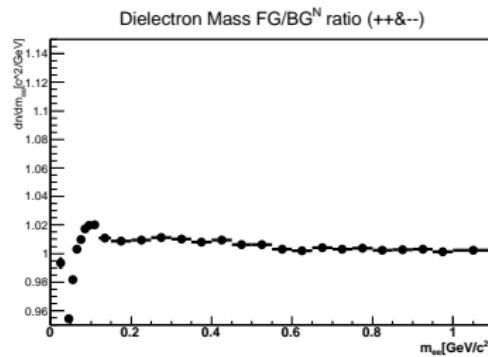
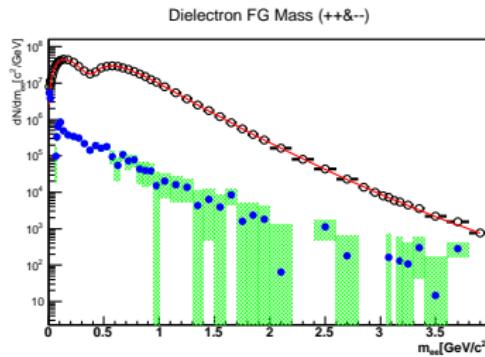
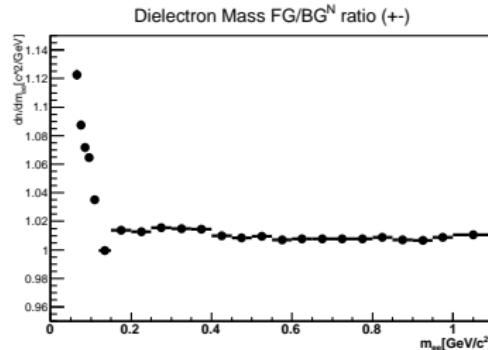
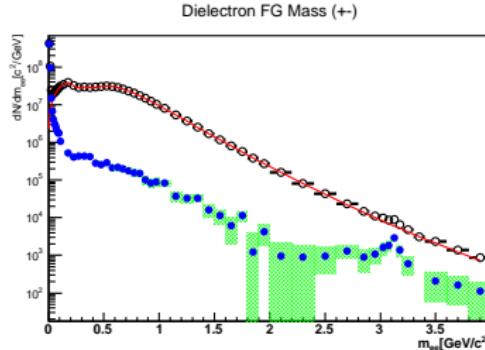
# $FG - N_{zyam} \times BG$ for 0-20% centrality

Before Any HBD cut



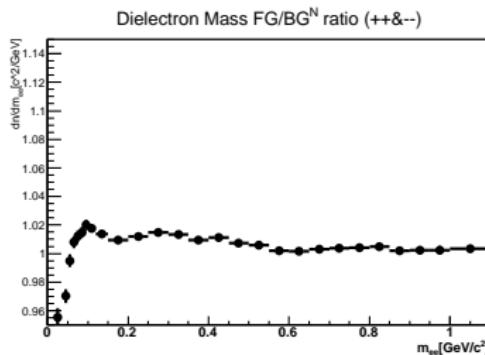
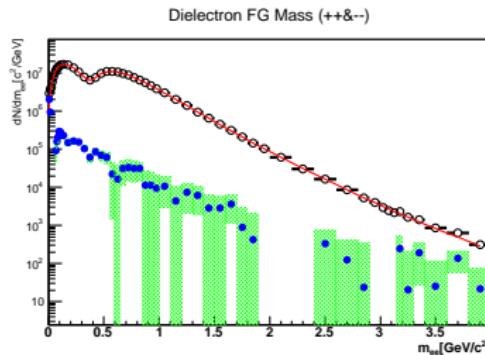
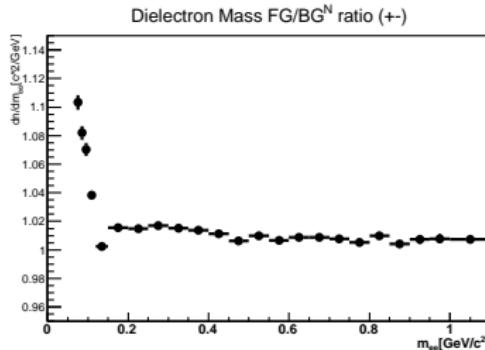
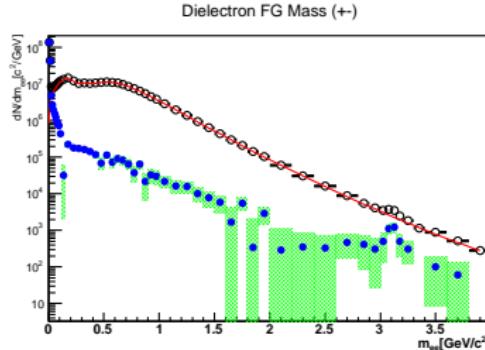
$FG - N_{zyam} \times BG$  for 0-20% centrality

After backplane conversion cuts



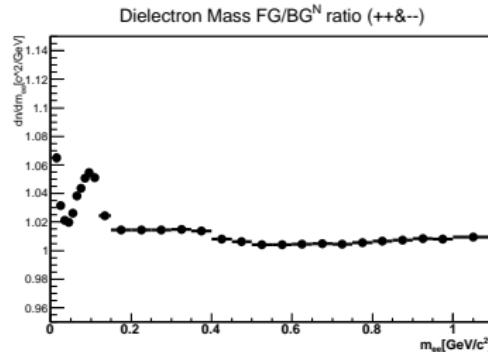
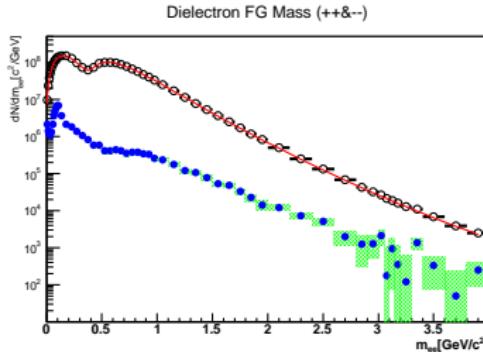
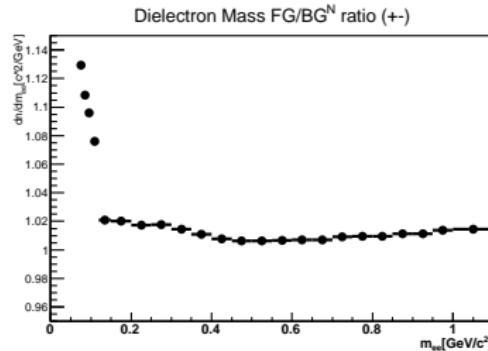
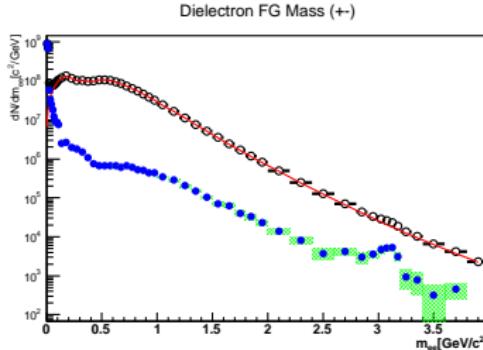
# $FG - N_{zyam} \times BG$ for 0-20% centrality

After backplane conversion and doubles cuts



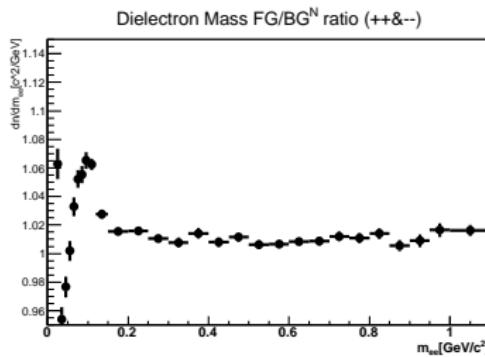
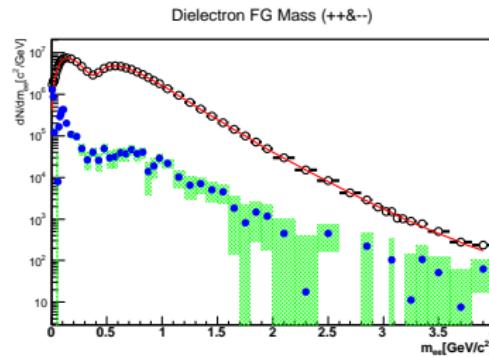
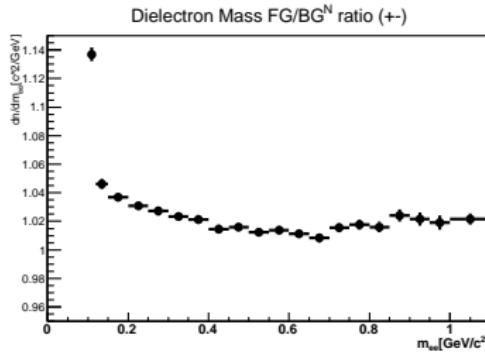
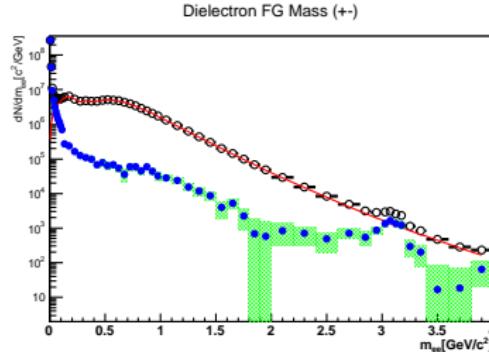
# $FG - N_{zyam} \times BG$ for 20-40% centrality

Before Any HBD cut



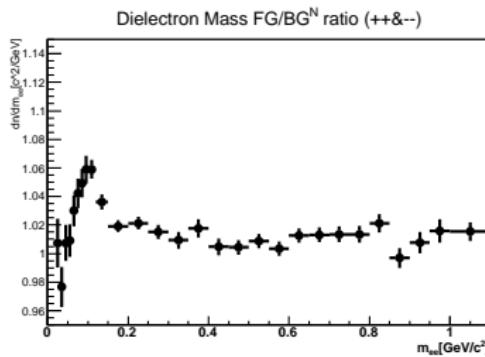
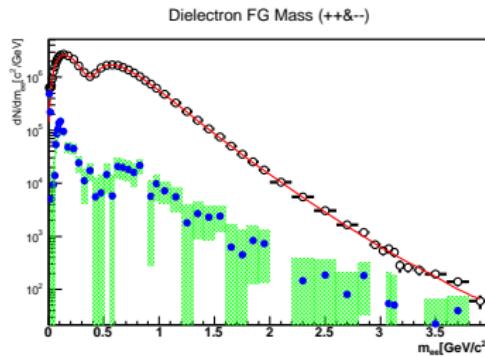
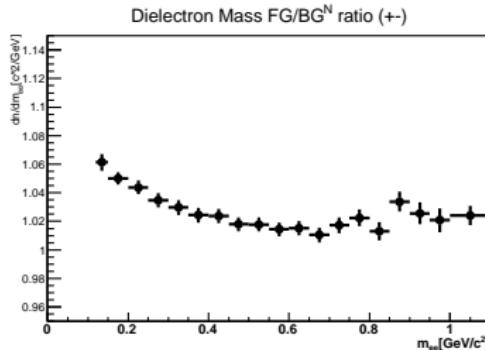
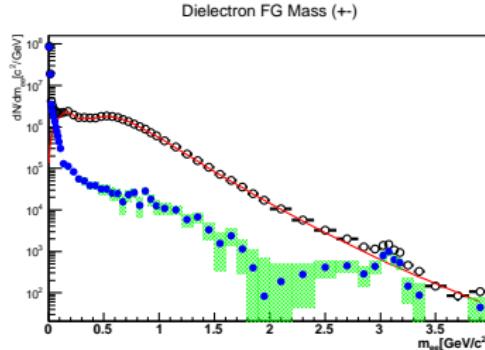
# $FG - N_{zyam} \times BG$ for 20-40% centrality

After backplane conversion cuts



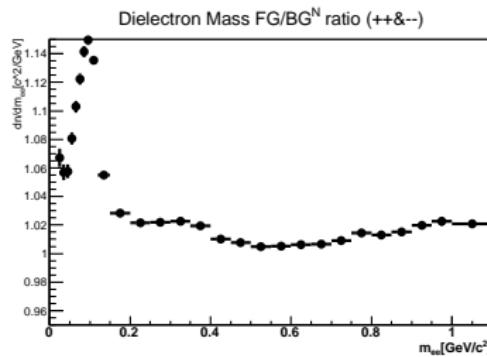
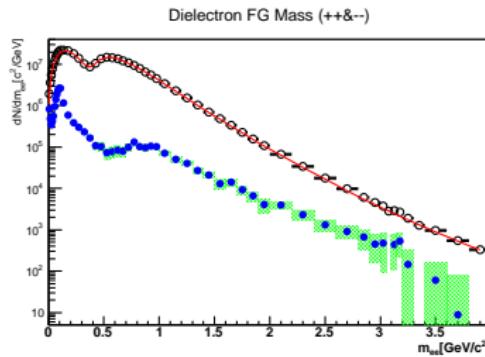
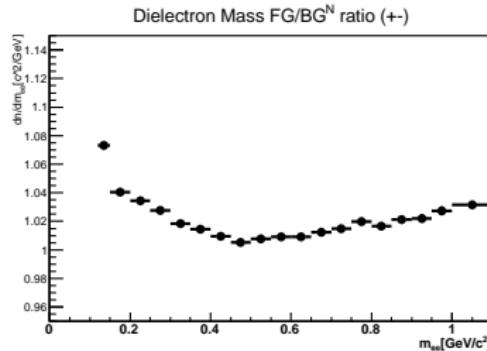
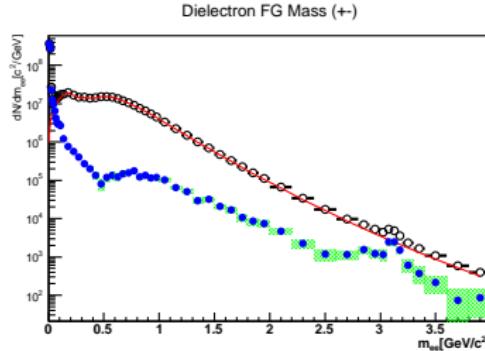
# $FG - N_{zyam} \times BG$ for 20-40% centrality

After backplane conversion and doubles cuts



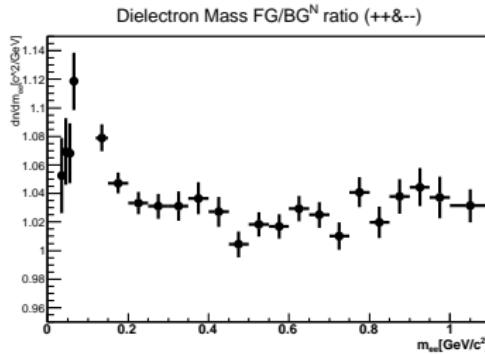
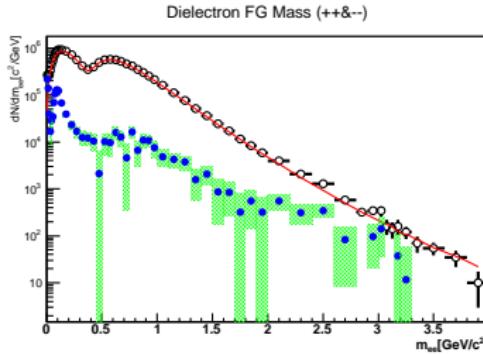
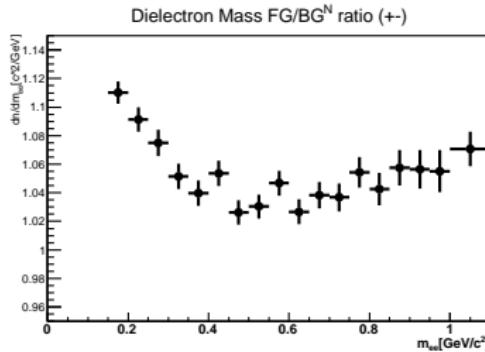
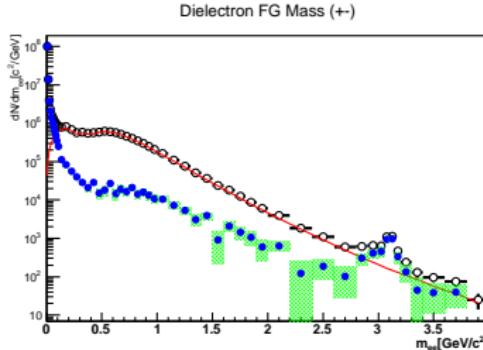
# $FG - N_{zyam} \times BG$ for 40-60% centrality

Before Any HBD cut



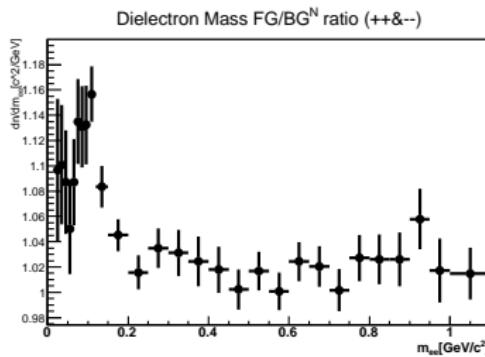
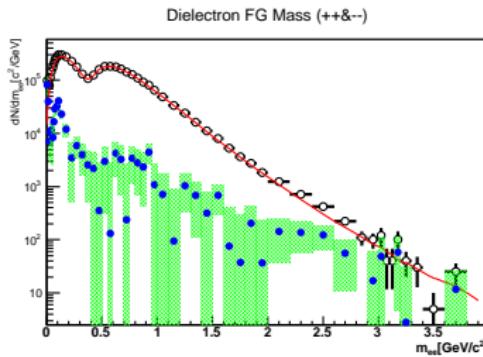
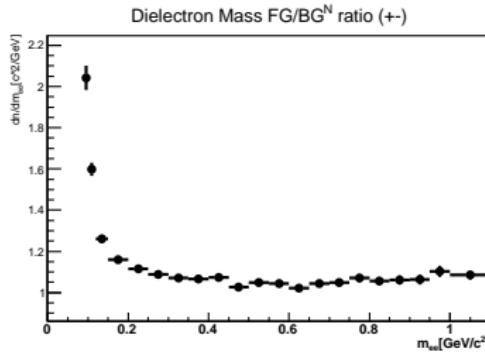
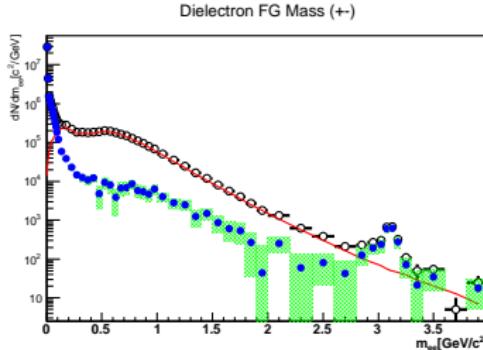
# $FG - N_{zyam} \times BG$ for 40-60% centrality

After backplane conversion cuts



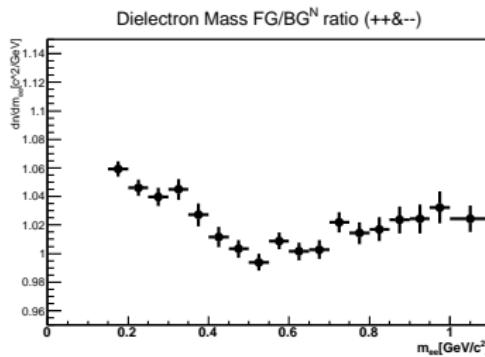
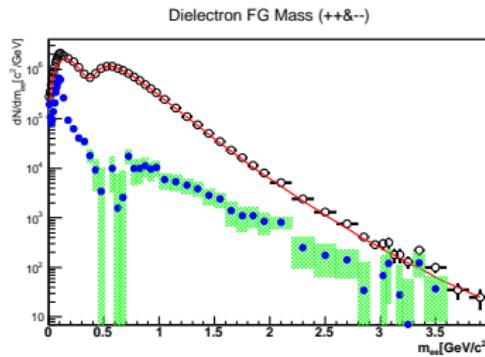
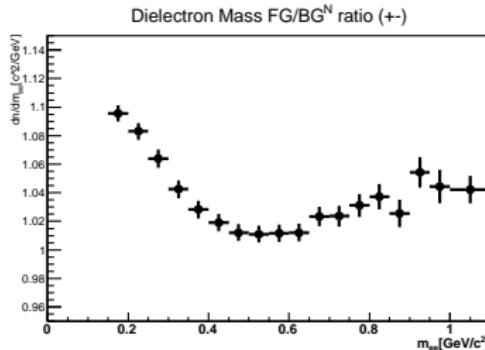
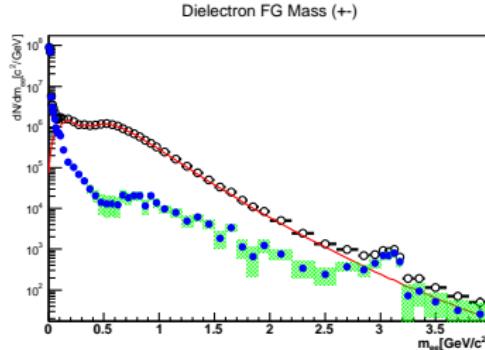
# $FG - N_{zyam} \times BG$ for 40-60% centrality

After backplane conversion and doubles cuts



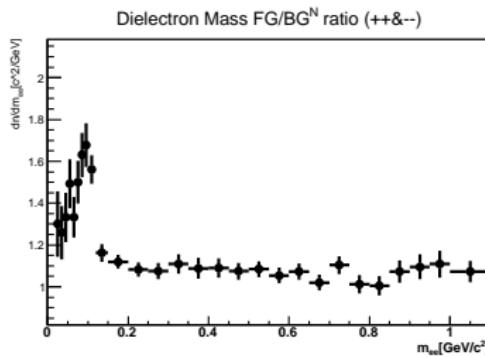
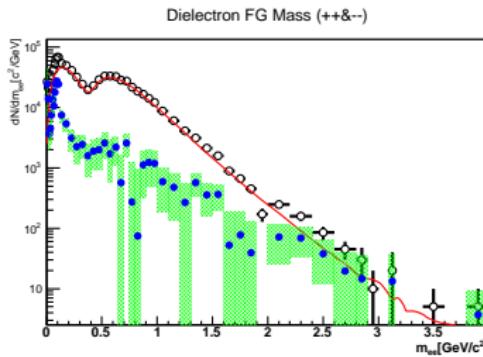
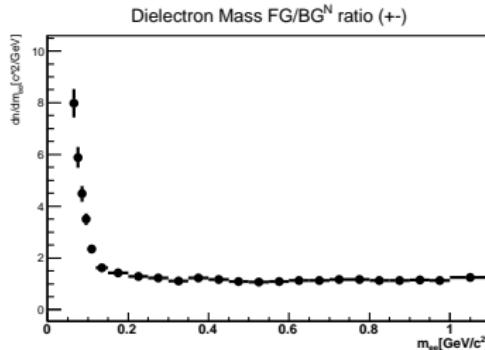
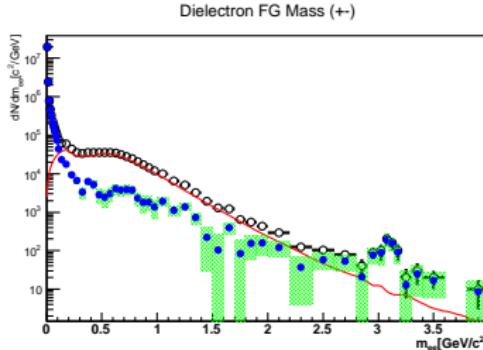
# $FG - N_{zyam} \times BG$ for 60-92% centrality

Before Any HBD cut



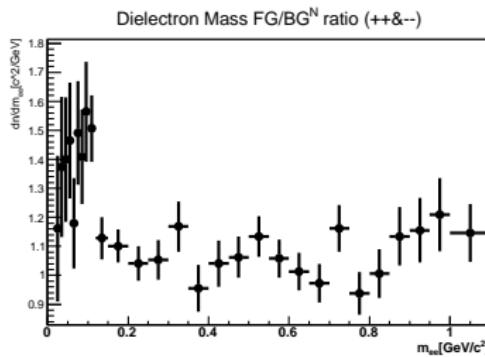
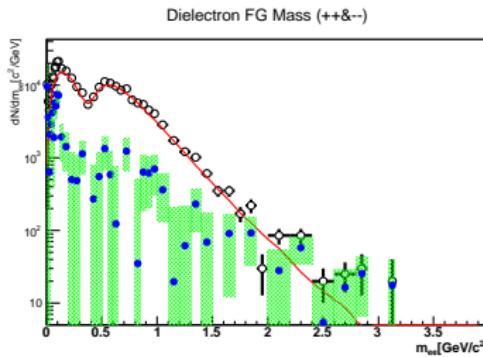
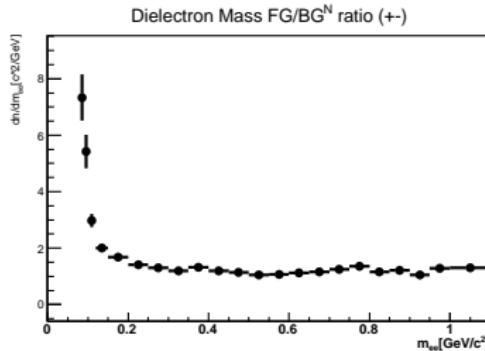
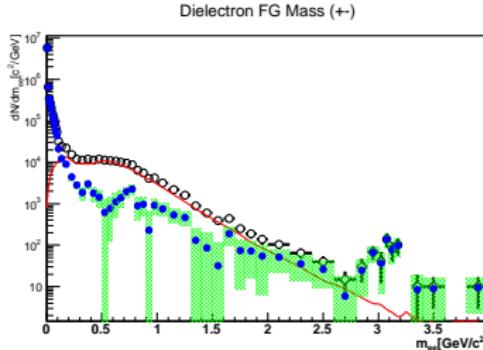
# $FG - N_{zyam} \times BG$ for 60-92% centrality

After backplane conversion cuts



# $FG - N_{zyam} \times BG$ for 60-92% centrality

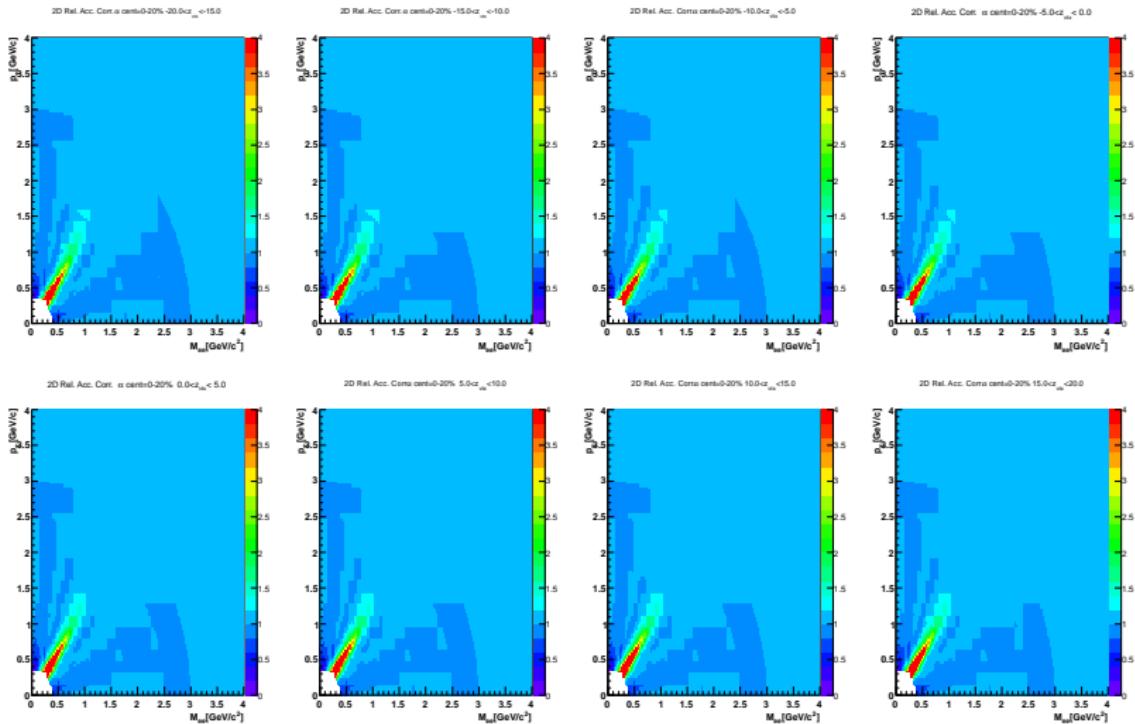
After backplane conversion and doubles cuts



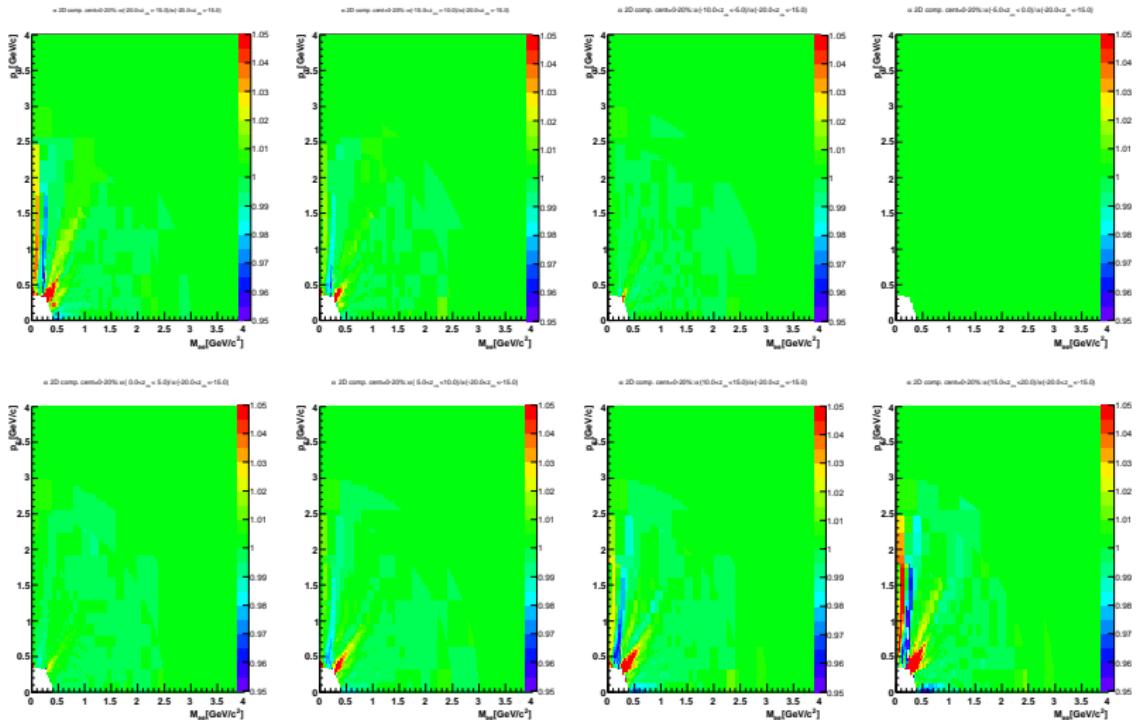
## Step 2: Relative acceptance correction

- Rel. Acc.  $\alpha$  is evaluated and applied in each cent, zvtx pool.
- For now  $\alpha = BG12/(BG11 + BG22)$  is used to correct correlated like sign.
- $\alpha$  is variably rebinned in  $m$  vs  $p_T$  to offset low statistics at high  $m_T$ . Fine bins are used at low  $m_T$  and they get wider as one goes out in  $m_T$
- The plot shown below are for one  $z_{vtx}$  and centrality bin, but it's done for all.
- All the relative acceptance plots shown here are calculated before HBD cuts are applied.

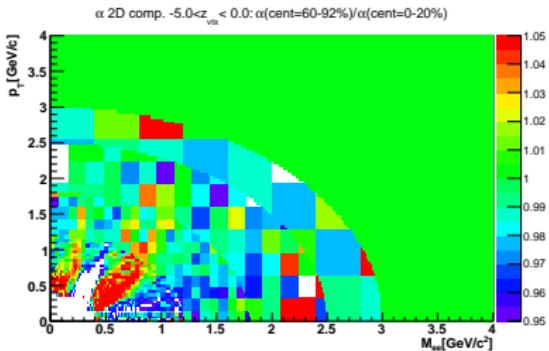
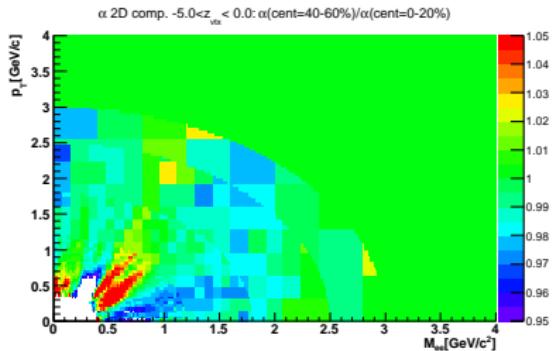
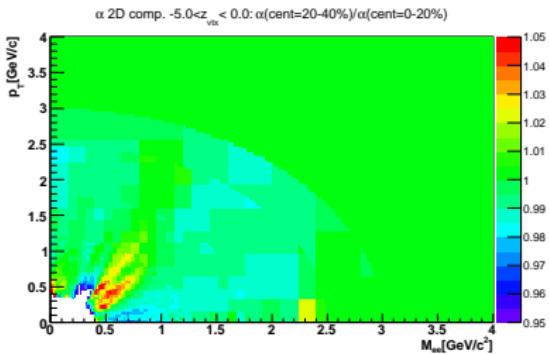
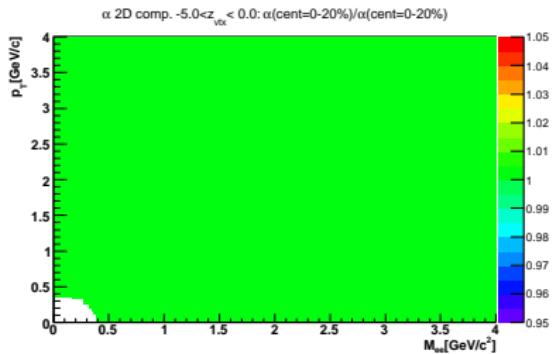
# $\alpha$ in $m$ vs $p_T$ for cent=0-20%



# $\alpha$ comparison across $z_{vtx}$ pools for cent=0-20%



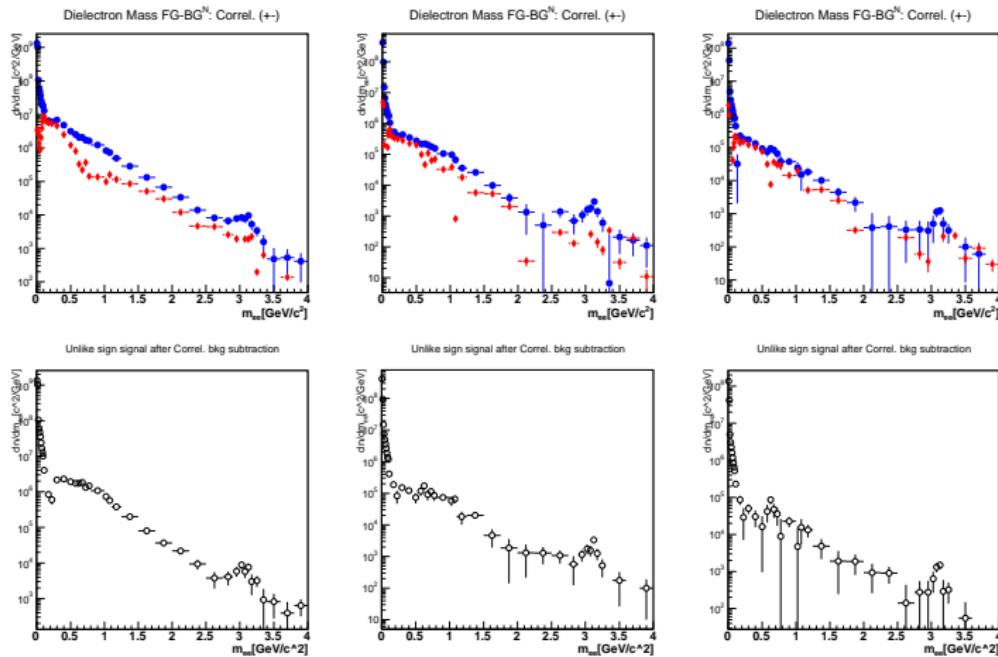
# $\alpha$ comparison across centrality for $-5.0 < z_{vtx} < 0.0$



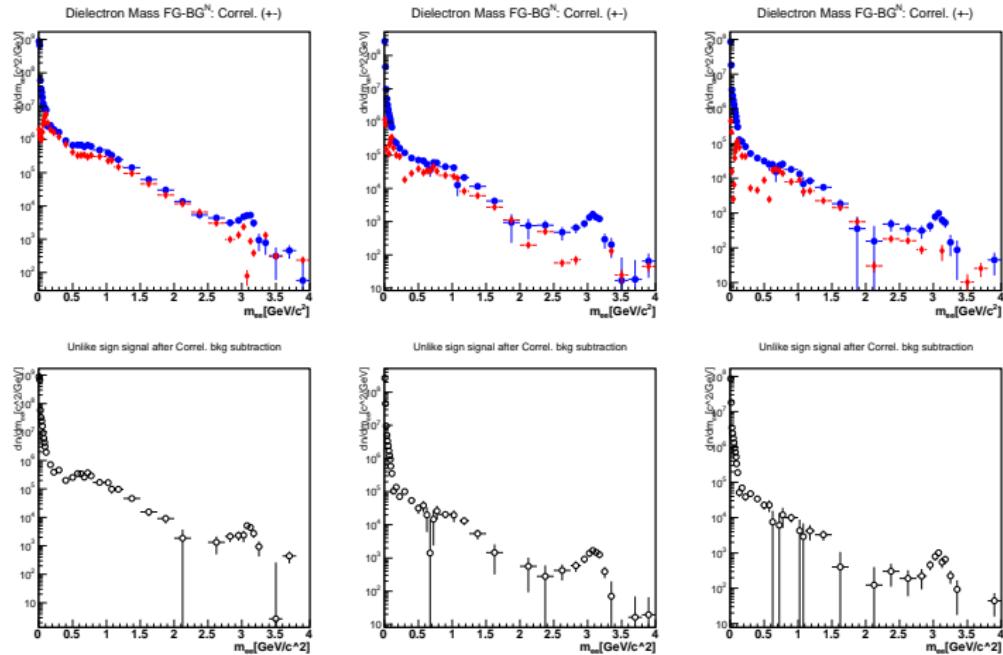
## Step 3: Subtraction of correlated background

- At this point we have all the ingredients (in  $m$  vs.  $p_T$ , for each centrality vs.  $z_{vtx}$  pool)
  - Combinatorial subtracted unlike sign foreground ( $FG12 - N_{zyam} \times BG12$ ), or signal plus correlated background
  - Combinatorial subtracted like sign foreground ( $FG11 + FG22 - N_{zyam} \times (BG11 + BG22)$ ), or correlated background
  - Conveniently rebinned relative acceptance correction  $\alpha$
- The last two steps are
  - Correct  $FG11 + FG22 - N_{zyam} \times (BG11 + BG22)$  by  $\alpha$  and subtract from  $FG12 - N_{zyam} \times BG12$  in each centrality vs.  $z_{vtx}$  pool
  - Sum across  $z_{vtx}$  pools
- In the following slides each resulting spectrum is shown for the three HBD cut steps (no, backplane, backplane and double)

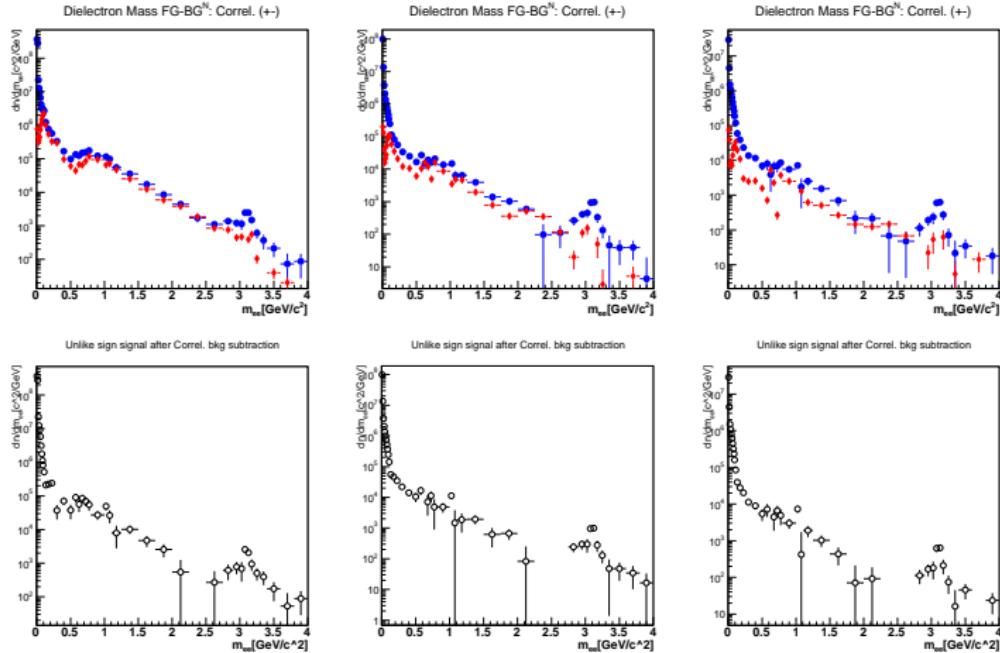
# Signal after all background subtraction, 0-20%



# Signal after all background subtraction, 20-40%



# Signal after all background subtraction, 40-60%



# Signal after all background subtraction, 60-92%

